vectors

VECTORS vs SCALAR

A *scalar* quantity is one that can be described by a single number:
temperature, speed, mass

A *vector* quantity deals inherently with both magnitude and direction:
velocity, force, displacement

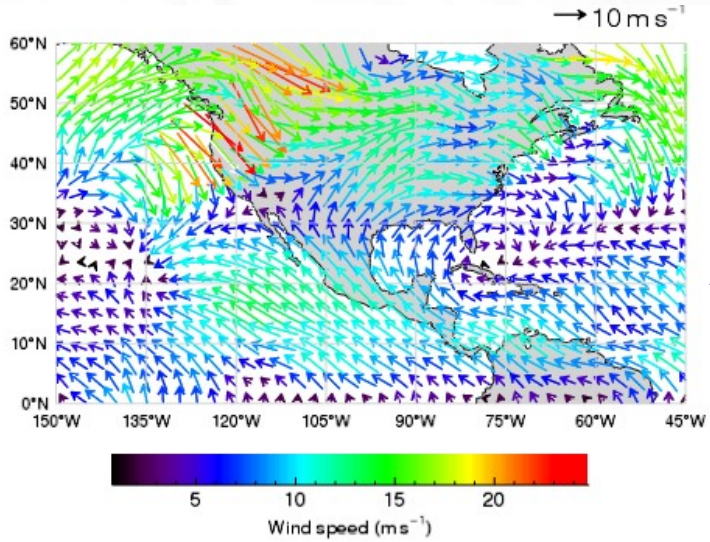
HOW MUCH ? OF WHAT ? WHICH WAY ?

WHICH quantity is not a vector

1. force
2. speed
3. acceleration
4. displacement

WHICH quantity is a scalar

1. distance
2. velocity
3. acceleration
4. displacement



This map shows the velocities of the Wind. The velocities have a magnitude (speed of wind from 0 to 25. The length of the arroas Are proportional to the magnitude) , a direction (which way), And a unit (m/s).

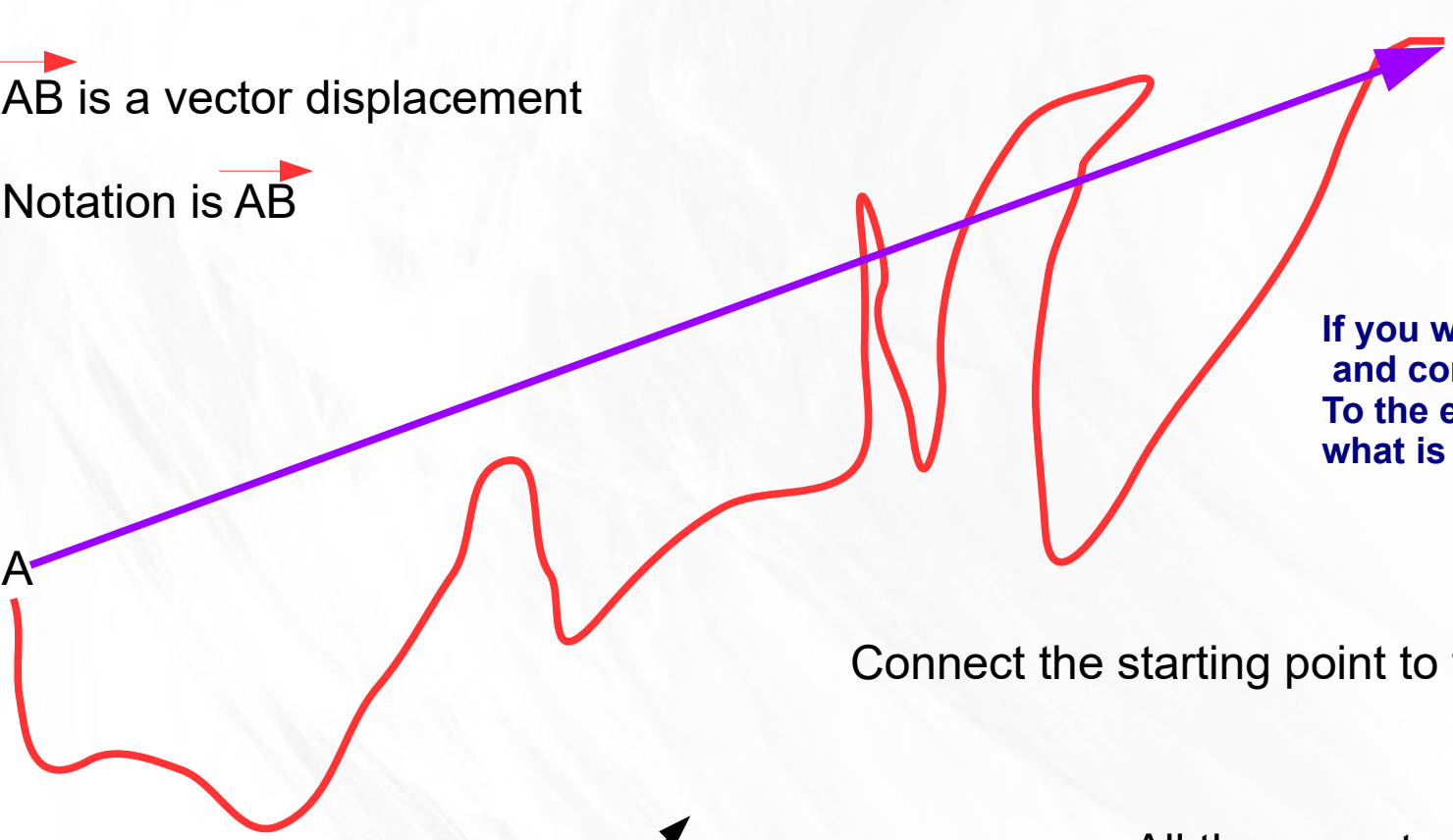
Colors are also used to show the magnitude.

https://www.harrisgeospatial.com/docs/vectors.html

Trace the vector displacement : connect the starting point A to the end point B. A is is the tail of the vector and B the head.

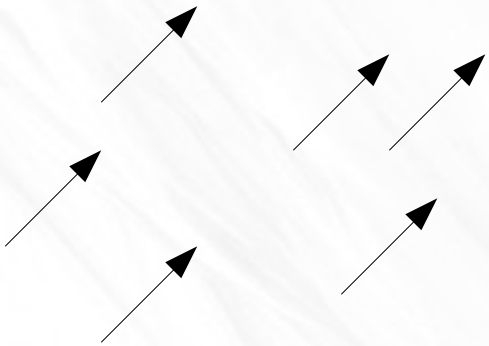
$\overrightarrow{AB}$ is a vector displacement

Notation is $\overrightarrow{AB}$



If you walk for a while and come back To the exact same place, what is your displacement ?

Connect the starting point to the ending point !



All those vectors have the same Length, the same direction : They are equal to teach other.

The vector represents the displacement NYC – Detroit.
It is has magnitude, a unit, a direction

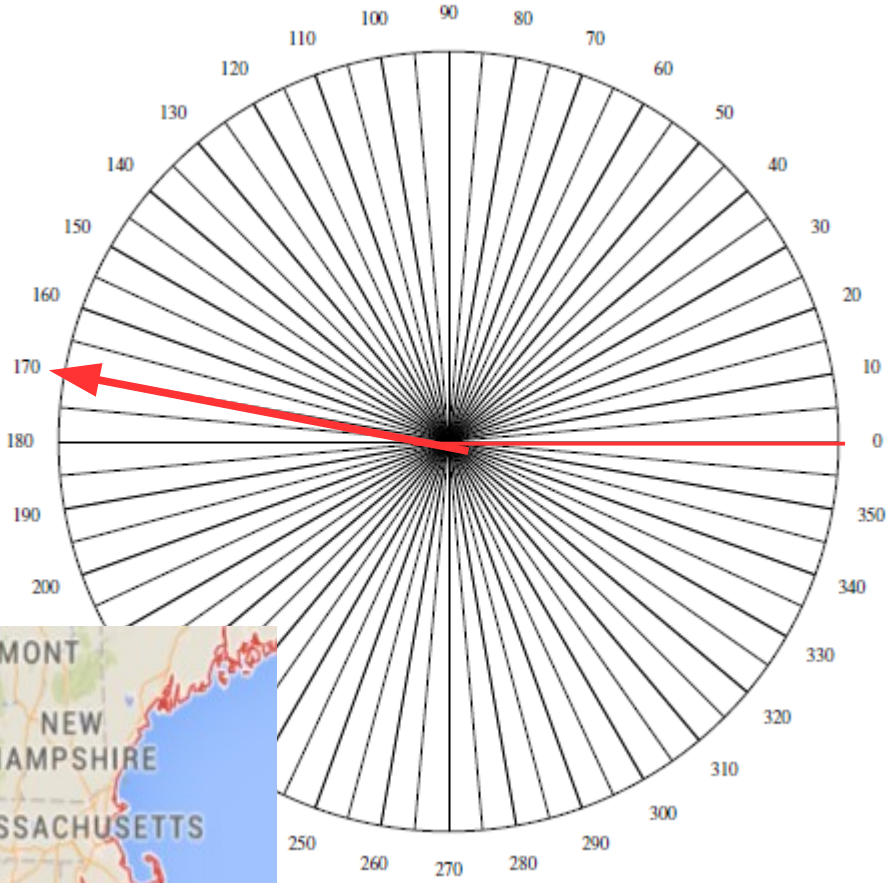
Displacement = _____ @ _____
The distance is in blue is a scalar.

Displacement = 600miles @ 10 degrees N of W

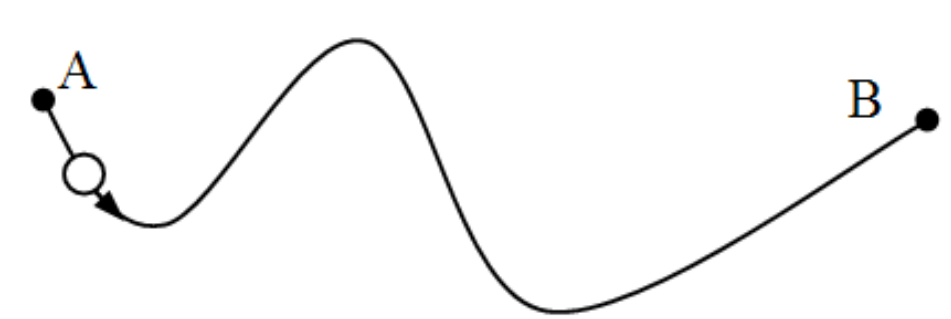
In Physics / Math we prefer
The notation:

600 miles @ 170

It is the polar notation
Or standard notation
See doc polar coordinate.



A particle travels along a curved path between two points A and B as shown. Complete the following statement: The displacement of the particle does not depend on



a) the location of A.

b) the location of B.

c) the direction of A from B.

d) the distance traveled from A to B.

e) the shortest distance between A and B.

In each case what is the displacement and the distance.

a) An Olympic athlete is running around an oval track. (R= 10m)

b) A truck travels 4 miles west; and then, it stops and travels 2 miles west.

c) A ball rises 5m and falls 5m after being thrown straight up from the earth's surface.

Complete the following statement: Displacement is

a) a scalar that indicates the distance between two points.

b) a vector indicating the distance and direction from one point to another.

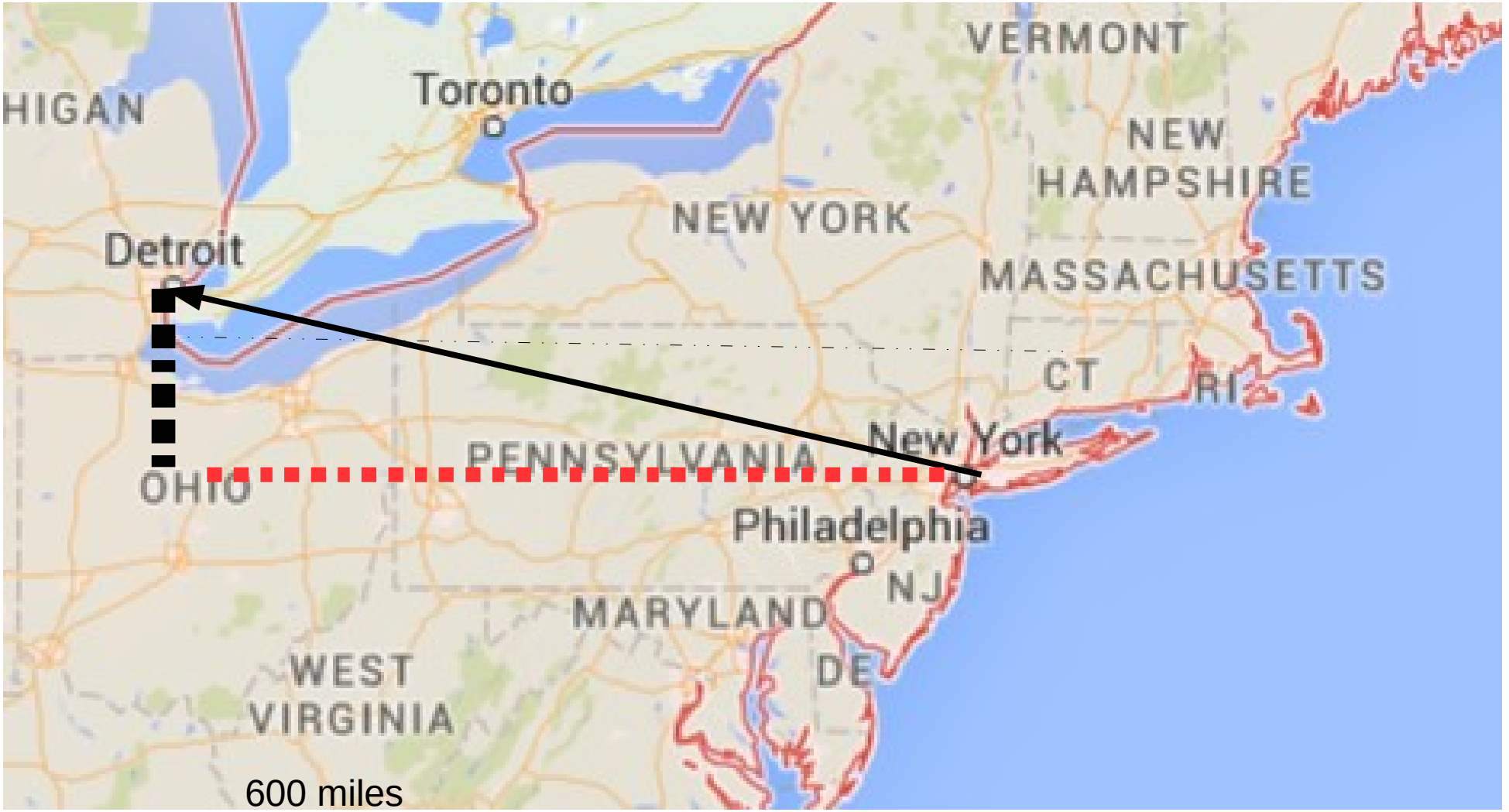
c) a measure of volume.

d) the same as the distance traveled between two points.

e) a vector drawn perpendicular to the line connecting two points.

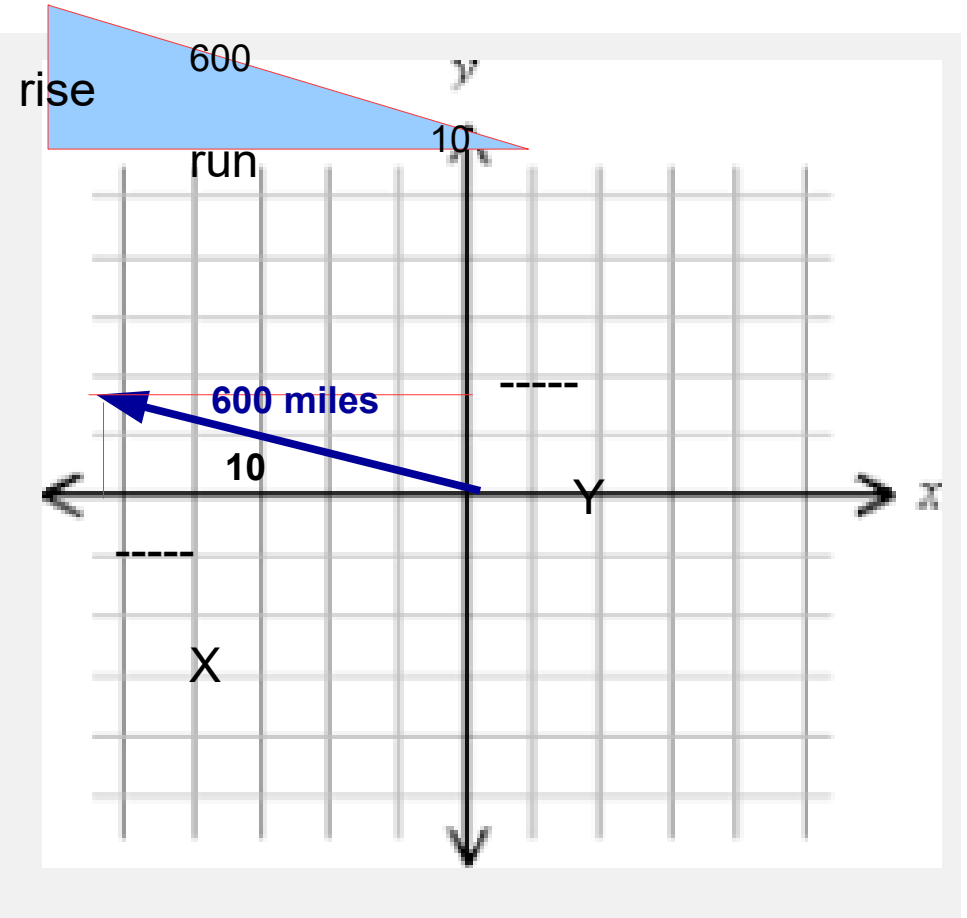
Vectors come in parts. A vector has 2 components in 2D.
A horizontal component along the x-axis or W-E direction
and a vertical component along the y-axis or the S-N direction

Here you can find how far in the West direction and how far in the North direction



Find the components of the vector displacement.
The magnitude is 600 miles and the angle is 10 degree. Use trig.

We can use the polar coordinate to switch to Cartesian coordinate
To find the components X and Y of the vector displacement 600 miles @ 170 degrees (or 600 miles @ 10 degrees N of W)



2 ways to do it :

#1. Extract the blue triangle

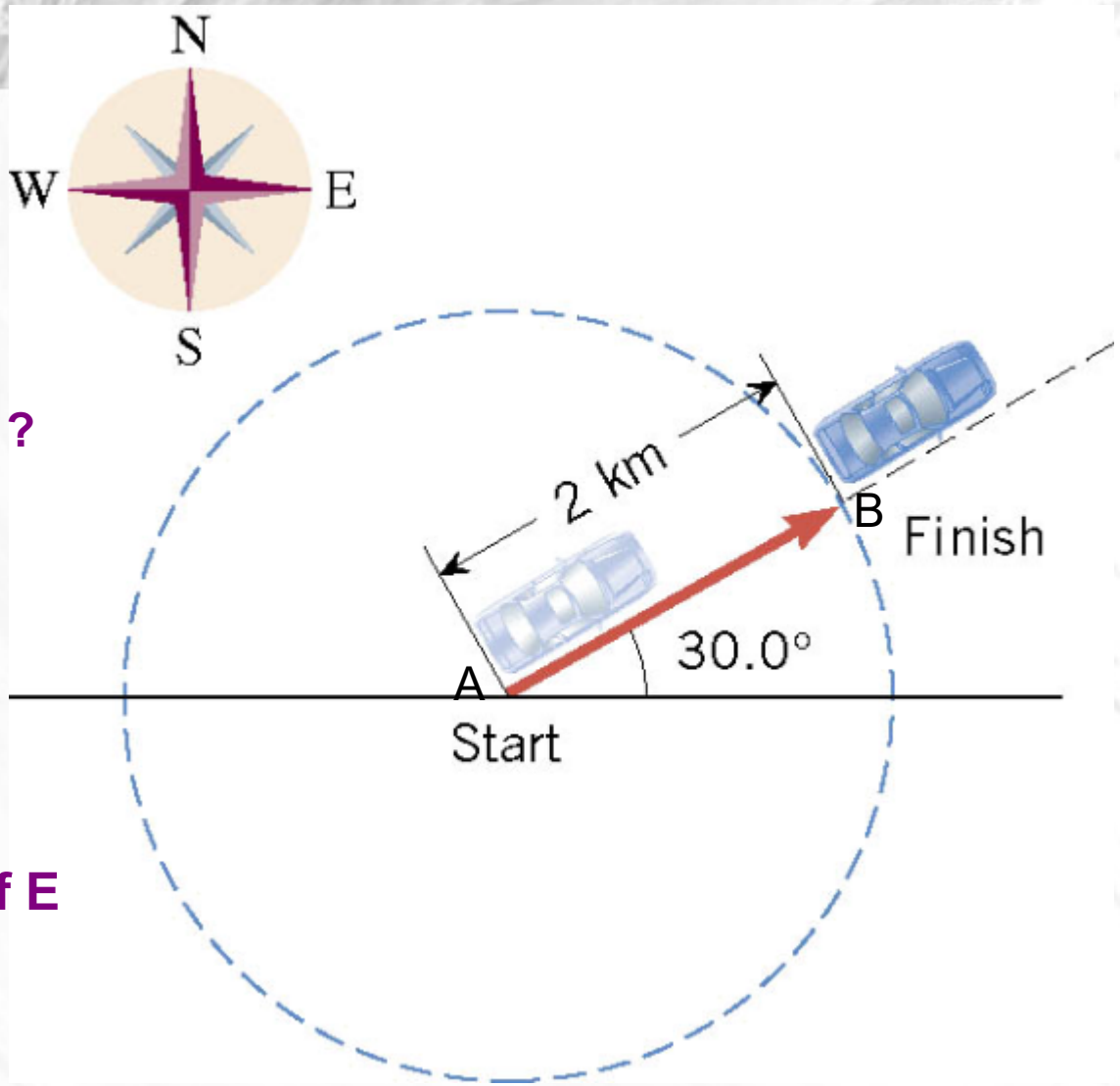
run = 600 cos(10) =591 then X<0
So X= - 591 miles or 591miles@W
Rise = 600 sin(10) =104
Y=104 miles or 104 miles @ N

#2. Use standard notation:
The angle is 170 degrees

X= 600 cos(170)= -591 miles
Y=600 sin(170).= 104 mies

This is easier as you don't
Worry about the signs.

So the components of the displacement are X=-591 miles Y=104 miles
The object moved 591 @ west and 104 miles at north.



What is the displacement of the car ?
(2 answers are correct)

1. $\vec{AB}$ = 2km @ 30 degrees

2. $\vec{AB}$ = 2 @ 30 degrees N of E

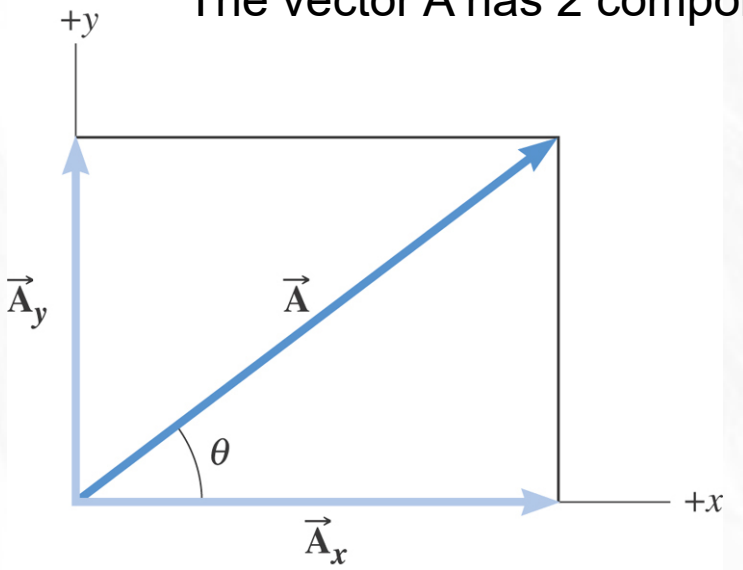
3. $\vec{AB}$ = 2km @30 degrees N of E

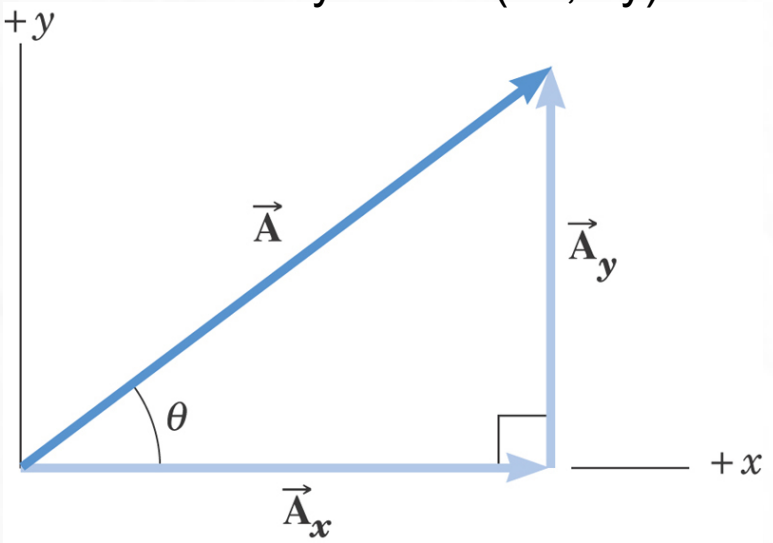
4. $\vec{AB}$ = 2 km @ 170 degrees N of E

Compute the components of the vectors displacements

VECTORS in PARTS

The vector A has 2 components in the Cartesian system A (Ax, Ay)





If **A is a vector displacement** (walking/moving from start to end) Then Ax is the horizontal displacement or x-component. (how far did you move along horizontal or here @ east). Ay is the vertical component or y-component how far did you move along vertical or here @ North).

If **A is a velocity**. Ax is how fast you move along horizontal Or how fast you move @ east. Ay is how fast you move along Vertical or @ North.

. Vector $\vec{a}$ has components $a_x = 15.0$ and $a_y = 9.0$. What is the approximate magnitude of the vector a?

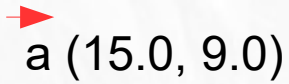
a) 12.0

b) 24.0

c) 10.9

d) 6.87

e) 17.5



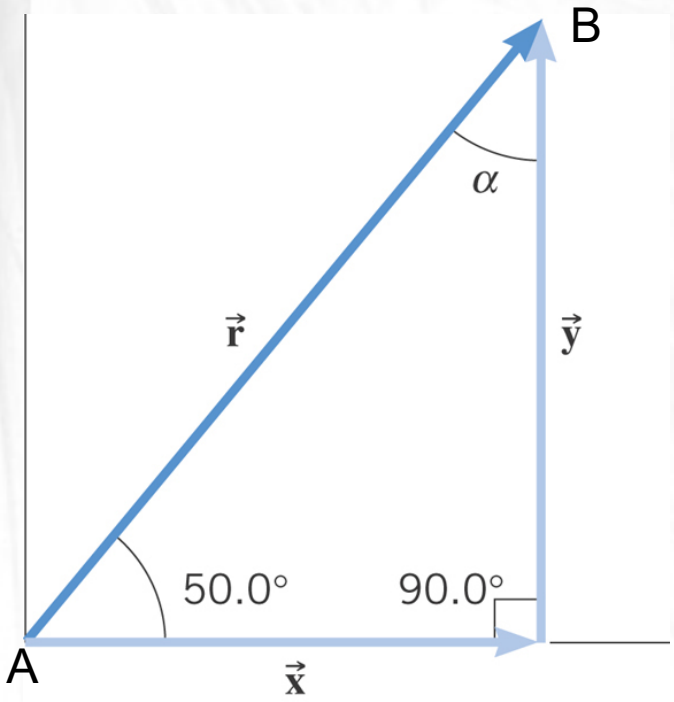
Trace the vector in the coordinate system.
Use Pythagorean theorem

https://phet.colorado.edu/sims/vector-addition/vector-addition_en.html

Example

A displacement vector has a magnitude of 175 m and points at an angle of 50.0 degrees relative to the *x* axis. Find the *x* and *y* components of this vector.

- **R = 175m@50 degrees CCW about x-axis**



X and Y (round to nearest one) :

1. 209m m and 134 m

2. 134m and 113m

3. 113m and 134m

A) During the execution of a play, a football player carries the ball for a distance of 33 m in the direction 76° north of east. To determine the number of meters gained on the play, find the northward component of the ball's displacement.

Trace first the vector !!!!

a) 8.0 m

b) 16 m

c) 24 m

d) 28 m

e) 32 m

33sin(76)

1) a vector velocity is V = 30mph@ 20 S of E (in the 4th quadrant)
Find the components of the velocity

2) a vector acceleration is a has a x-component of 10m/s. The angle is 40 degrees.
What is its y-component ? (use tangent)

3) a vector displacement is 50 miles @ 10 degrees N of W (2nd quadrant)
What are its components.

4) a vector has the components (-20, -10). (third quadrant)
A) Trace the vector in a polar coordinate system.

B) Use tangent to find the angle relative to the x-axis.

C) what is the magnitude of the vector

D) what is the standard notation of the vector.

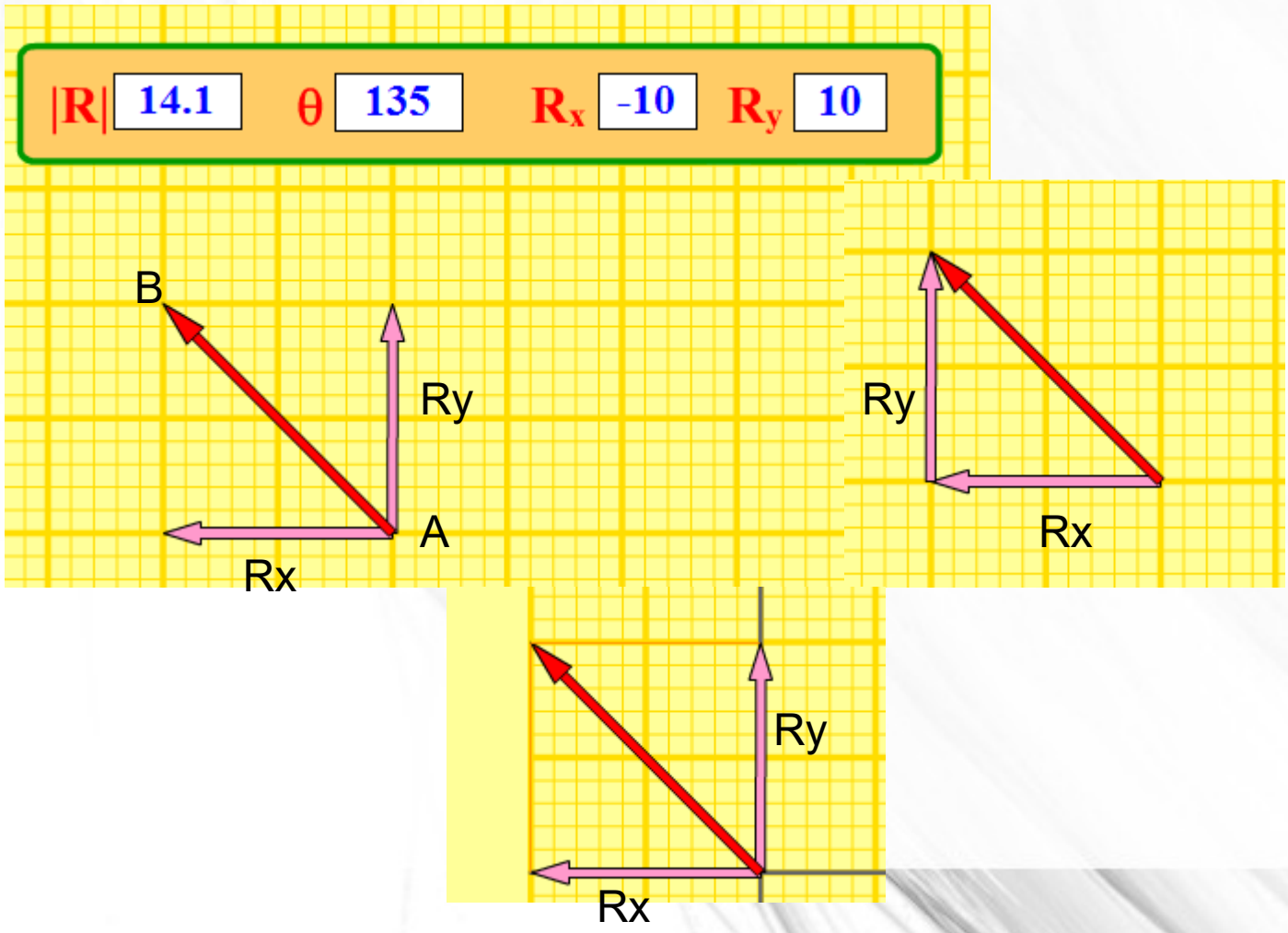
5) Same question for:

(-20, 10) (20,10) (20,-10) .

Play with :

https://phet.colorado.edu/sims/vector-addition/vector-addition_en.html

We can represent the components 2 ways:



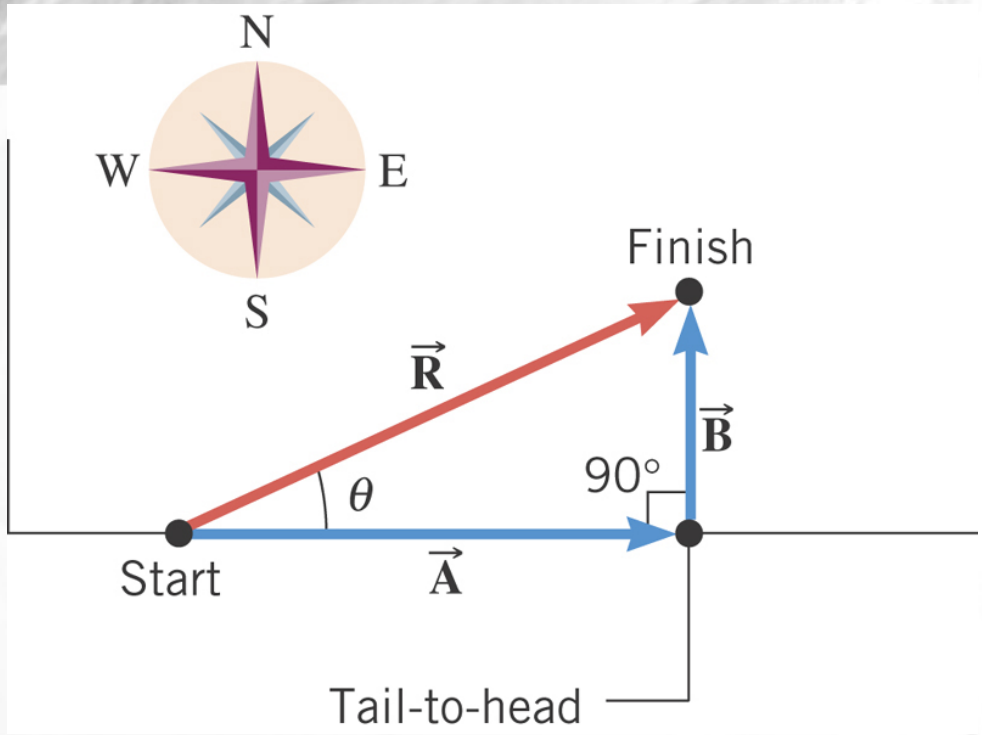
You walk 6m@ east and 2m@ north
What is your final displacement

1. 6.32 m @ 19.5

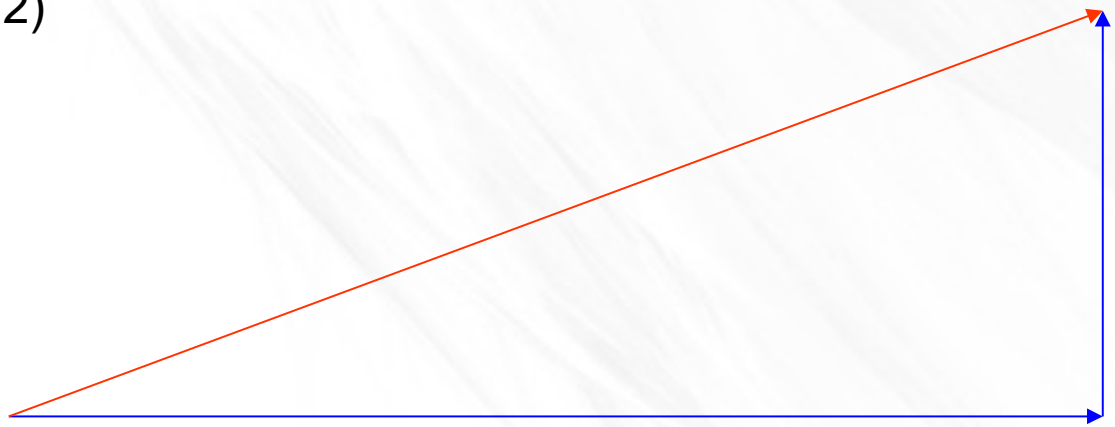
2. 6.32m @ 70.5 N of E

3. 6.32 m @ 18.4

4. IDK



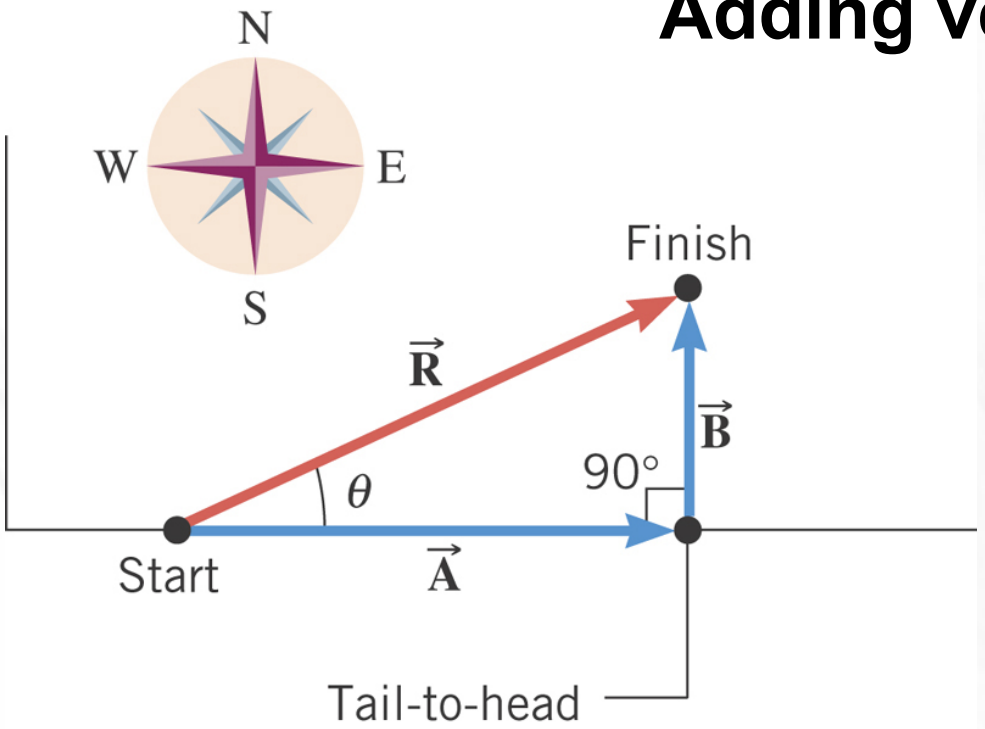
R (6, 2)



2.00 m

6.00 m

Adding vectors



This is adding vectors. A + B = R using the tail to head method.

http://www.tutorvista.com/physics/adding-vectors-graphically

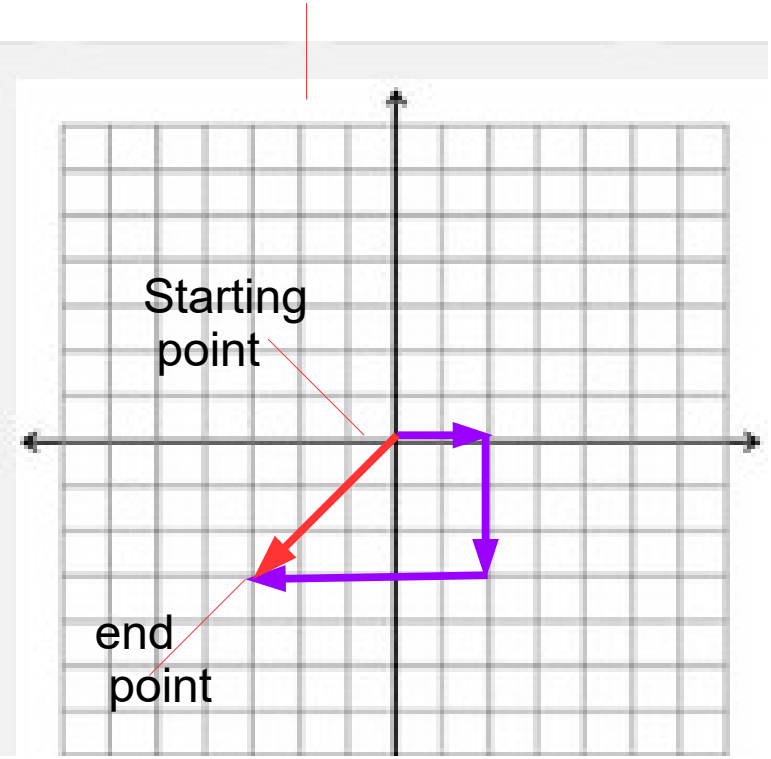
Practice here:

https://phet.colorado.edu/sims/vector-addition/vector-addition_en.html

In 2D : if you add vectors geometrically place them tail to head.
The sum is the vector that connect the tail of the first to the head of the last one
Here are easy examples:

1) From the origin You move 2 blocks eastward, 3 blocks southward and 5 block westward.
What is the final displacement From your starting point (origin here) ?
The vector sum is in black. The vector sum connects the starting point to the end point.

sum = **(-3,-3)** or **sum = ____ block @ 225** Use Pythagorean and tangent as previously

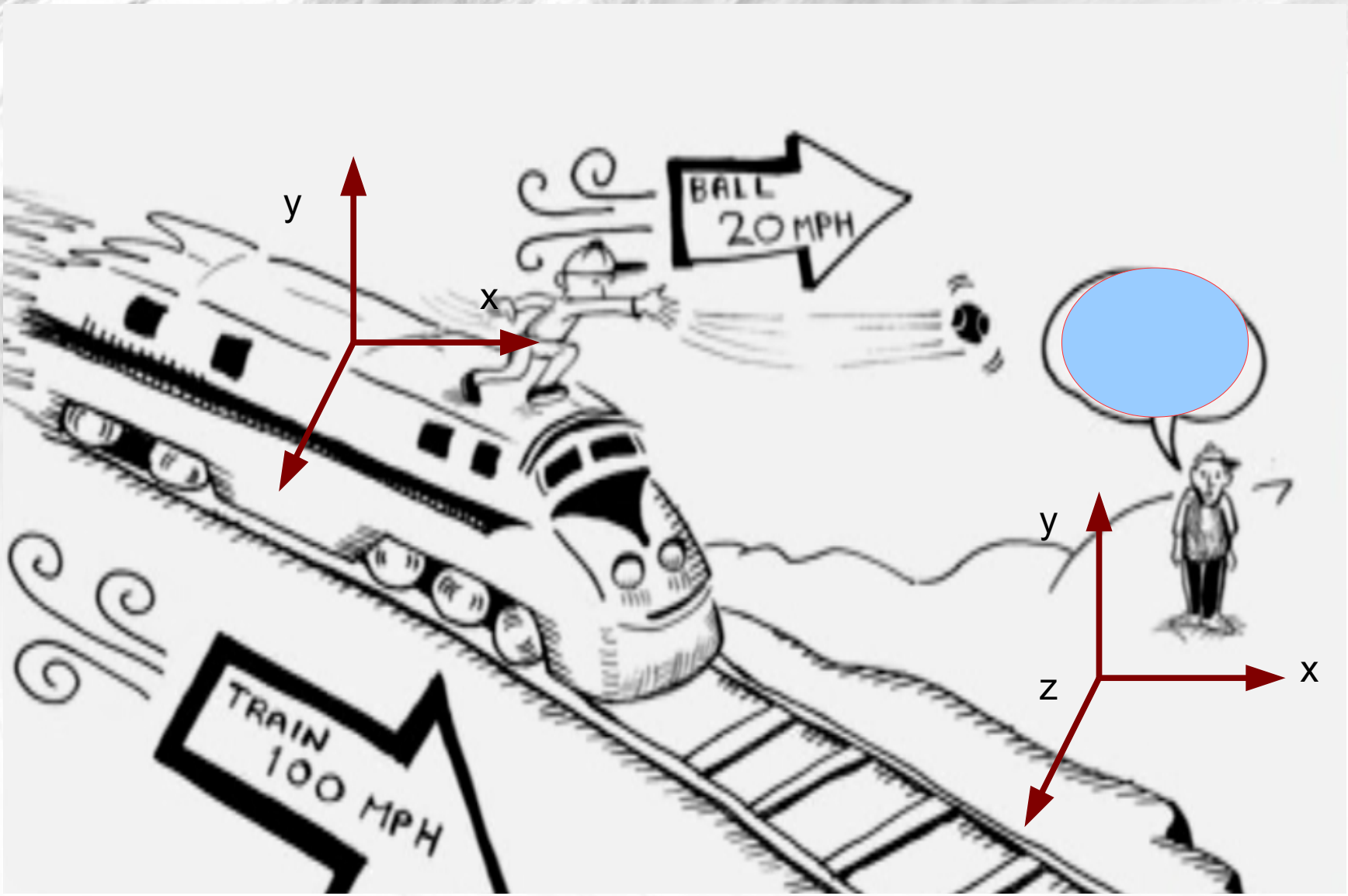


2) do the same for:

6 block westward , 3 blocks
southward , 1 block west ward

3) 4 blocks North , 2 block
eastward, 3 blocks southward

4) 5 blocks south, 3 blocks west,
3 blocks east, 2 blocks north.

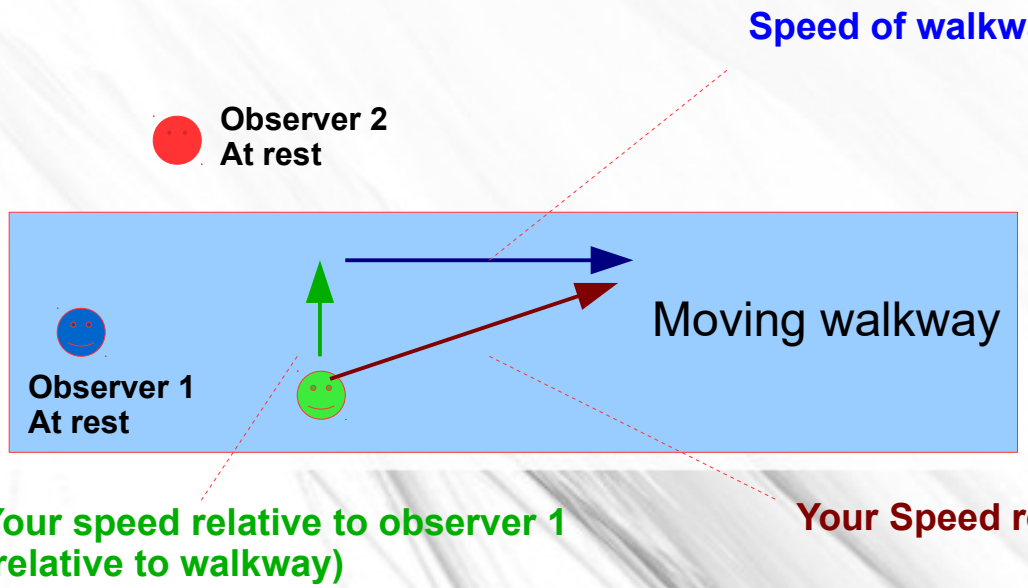


The velocity is relative. It depends the <u>frame of reference</u> it is measured in.
For the person watching the train (observer) how fast the train is going?[22]
How fast the ball is going ?.
For the person on the train. How fast the ball is going ?

Moving walkway

Do demo river

$\vec{V} = \vec{V1} + \vec{V2}$ Adding velocities = adding vectors



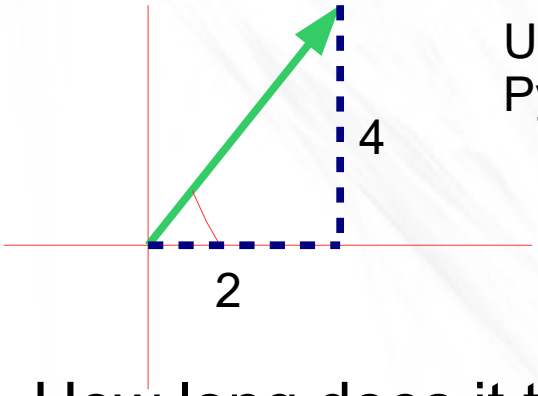
Describe the displacement
Of green man relative to
Observer 1 (on the walkway too)

Describe the displacement of
Green man relative to observer 2
Not on walkway.

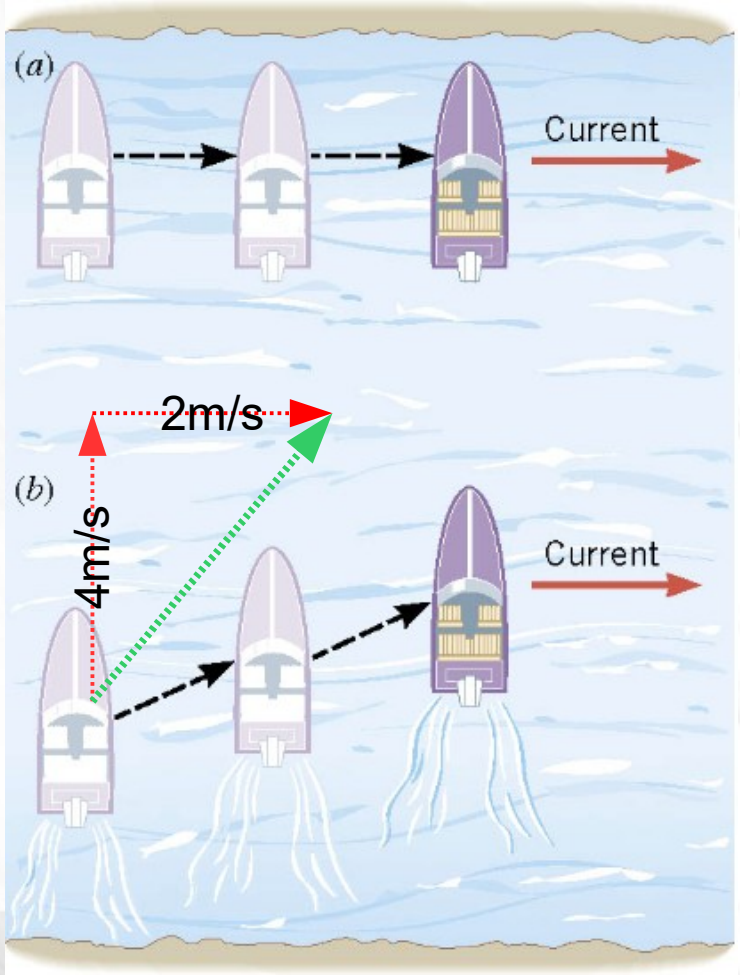
Example Crossing a River

The engine of a boat drives it across a river that is 1800m wide. The velocity of the boat relative to the water is 4.0m/s directed perpendicular to the current. The velocity of the water relative to the shore is 2.0m/s.

(a) What is the velocity of the boat relative to the shore?
So magnitude and direction



Use tangent and Pythagorean



- (b) How long does it take (s and min) for the boat to cross the river?
(use only the vertical component
Vy = distance/time)

PROBLEMS/ ADDING VECTORS / connect starting point to end point

1) you walk 7 miles south and then 3 miles west. What is your displacement from your starting point ?
(textbook)

2) A child is playing with a toy car on the floor on a train that is moving eastward. While the train travels 12.0m, the child pushes the car 2.6 m northward on the floor . What is the resulting displacement of the car ? That is the sum. (textbook)

3) Find the vector sum of 3.5m east and 5.8 m south. Give both magnitude and direction of the sum.
(textbook)

4) A boat can travel 4.0m/s in still water. It is in a river that flows southward at 5.5 m/s ?, as shown. If the boat heads eastward, directly across the river, what are the direction and magnitude of its total velocity ?
(textbook

See textbook for more